CGSN Standard and High Power Surface Buoy Recovery Procedure

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Approved: Paul K. Matthias
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Coastal and Global Scale Nodes
Ocean Observatories Initiative
Woods Hole Oceanographic Institution
Oregon State University
Scripps Institution of Oceanography
Template 3101-00023 Version 1-00

Revision History

Version	Description	Originator	Approver	Release Date
0-01	Initial Draft	S. White		
0-02	Updates from discussions with J. Kemp	S. White, M. Palanza		
1-00	Initial release	S. White	P. Matthias	2014-08-19
1-01	Updates from comments from: OOI Task 2 OSHA Report_082614	M. Palanza		

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1.0 Scope & Purpose

The procedure describes the recovery and handling procedures of Standard and High Power Surface Moorings deployed at OOI Global, Coastal Pioneer and Coastal Endurance Arrays.

The purpose is to specify safe handling procedures to deal with the possibility of hydrogen gas accumulation within the buoy well. Hydrogen gas mixtures in air are combustible in concentrations of 4% to 75% by volume. This procedure is based on similar procedures developed for the Nation Data Buoy Center (NDBC) (Health and Safety Instruction H.12.001)

2.0 Roles & Responsibilities

The Marine Operators in the OMCs have a responsibility to monitor and control the operations of the moorings during deployments, and to provide status information to the recovery personnel at sea.

The recovery personal at sea have the responsibility to safely recover the mooring. The CGSN Mooring Operations Lead and the Chief Scientist have joint responsibility (in consultation with the ship's Master) to determine the best, safest course of action given the situation.

3.0 Materials required

- 1 Handheld hydrogen gas sensors: RKI Eagle 2
- Q size cylinders of nitrogen gas with pressure regulator (at least one cylinder per surface buoy, and 2 spares)
- 1/2" ID Flexible tubing (length dependent on deck configuration, see Section 6.1))

4.0 Reference Documents

NDBC Health and Safety Instruction H.12.001

3701-00387 J-Box, Well Instrument Connector Panel Assembly

3701-00127 Surface Buoy Well Purge Hose Adapter Assembly

5.0 Definitions & Acronyms

LEL – Lower Explosive Limit (percent by volume in air)

NDBC – National Data Buoy Center

OOI – Ocean Observatories Initiative

OMC – Operations & Management Component

PSC – Power System Controller

6.0 Procedure

The procedure for recovering and handling Surface Buoys will depend on the state of the buoy, whether it is active, inactive, or unknown. Each of those scenarios are presented in the sections below.

WARNING – Personnel should stand clear of the top of the buoy well (area above the hatch) and the bottom of the buoy well. No approach should be made into this area until the buoy well environment has been verified. Only the minimal number of personnel required to complete a task should be in the vicinity of the buoy.

WARNING – No power tools or ignition sources of any kind should be used in the vicinity of the Surface Buoy.

6.1. Operational Monitoring:

During normal operations, surface mooring Hydrogen levels will be monitored and logged daily.

6.1.1. Monitoring:

On a daily basis a trained operator will log onto: http://cgsn-omc.whoi.edu/oms

Determine Hydrogen Level:

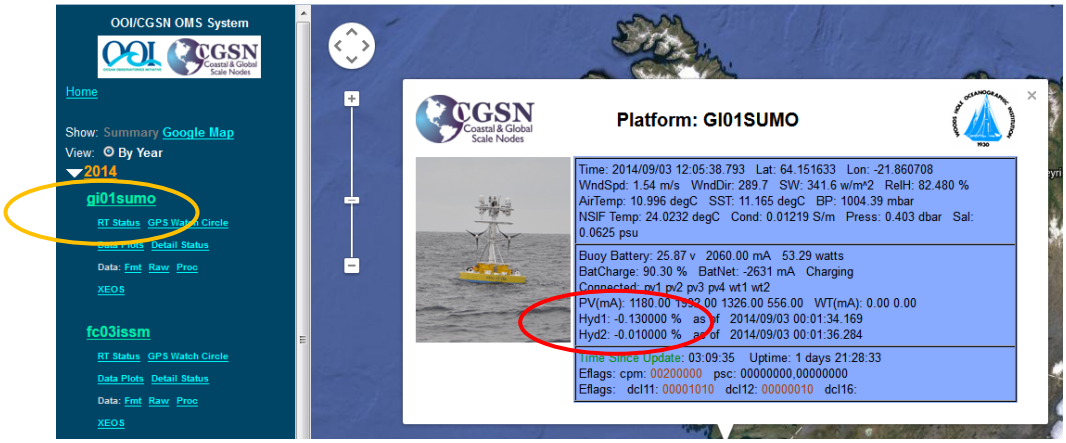

Figure 1: Buoy Real Time Status

6.1.2. Log Hydrogen Value

6.1.3. If value is greater than 25%:

6.1.3.1. Initiate Power System Override Procedure

6.1.3.2. Alert: Paul Matthias, CGSN Chief Engineer
Sheri White, CGSN Systems Engineer
Matthew Palanza, CGSN Lead Electrical Engineer

6.2. Pre-Recovery Planning

Prior to recovery, the shipboard personnel should be informed of the safety issues associated with Surface Buoy recovery, and what areas must be kept clear during recovery and post-recovery operations. Given the location the buoy will be placed on deck, a suitable location shall be identified (protected from the buoy and weather) to locate the hydrogen sensing equipment and nitrogen cylinders. Flexible hosing needs to be of sufficient length to connect from the buoy on deck to the hydrogen monitoring location.

6.3. Mooring Recovery Scenarios

Active Mooring Scenario Assumptions

- The Surface Mooring is operational and status is being reported on schedule to the OMC.
- The Surface Mooring can be controlled from shore via satellite telemetry, and/or from the ship via line-of-sight telemetry
- Power System and hydrogen gas concentration data/status are normal.

Unknown Mooring Scenario Assumptions

- The Surface Mooring is in an unknown state.
- There are no communications with the mooring.
- No status information can be obtained from the mooring.
- The state of the Power System is unknown.

6.4. Pre-Recovery Actions

6.4.1. Active Mooring Scenario

- **Stop battery charging** – Marine Operators (on shore or at sea) will remotely command power generation processes to stop for a minimum of 48 hours, and a maximum of 72 hours prior to the planned recovery. This will prevent any further hydrogen generation from battery charging prior to recovery.

The Power System Controller (PSC) autonomy will be overridden via a PSC Override Procedure, appendix n.

- **Determine hydrogen gas concentration** – Details on hydrogen concentration within the buoy well, as measured by the hydrogen sensor mounted in the well, will be communicated to the recovery team at sea by the Marine Operators.

All surface moorings are equipped with two internal Hydrogen sensors. The Hydrogen sensors measure Hydrogen concentration between 0% and 100% Lower Explosive Limit.

Data is available remotely via the shore side command and control site, and locally by logging onto the buoy directly.

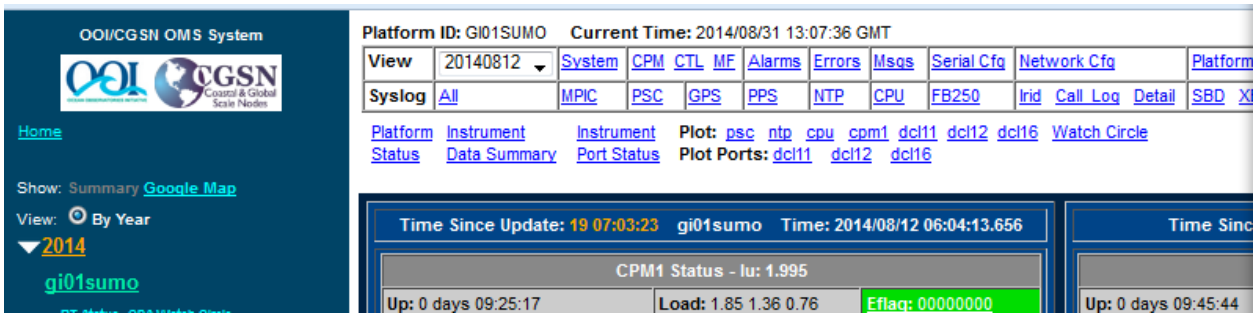

Figure 2: Detail of Command and Control Interface

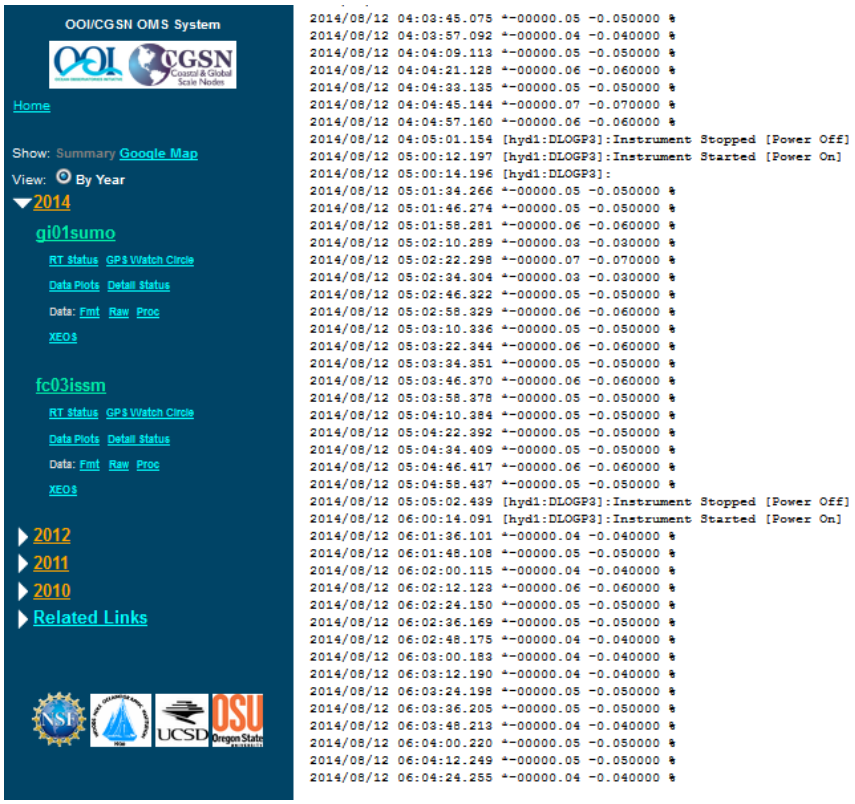

Figure 3: Hydrogen Sensor Data

6.4.2. Unknown Mooring Scenario

- **Visual inspection** – The ship will pass as close as possible to the mooring such that a visual inspection can be made.
  - Mechanically secure wind turbines
    - If possible a small boat operation will be considered to mechanically secure the wind turbine blades.
  - Inspect vent valves for any signs of blockage.
    - If possible clear any blockage

6.5. Recovery Actions

WARNING – Personnel should stand clear of the top of the buoy well (area above the hatch) and the bottom of the buoy well. No approach should be made into this area until the buoy well environment has been verified. Only the

minimal number of personnel required to complete a task should be in the vicinity of the buoy.

WARNING – No power tools or ignition sources of any kind should be used in the vicinity of the Surface Buoy.

NOTE – Once the buoy is on deck in a ~45% orientation, the buoy vent valves act as one way check valves. Atmosphere can be actively pumped out, but passive ventilation is prevented.

1. **Recover Surface Buoy** –

Figure 4: ESD Ground Strap

   A. Surface Moorings will nominally be recovered buoy first, with the buoy being brought aboard on the starboard side of the ship.
   B. Connect ESD ground strap to instrument well grounding strap prior to touching the ship.
   C. Connect ESD ground strap to ship.
   D. Once the buoy is brought on deck, minimal tie-downs will be applied to the sides of the buoy as needed given the sea state conditions.

2. **Measure hydrogen concentration of buoy well** –
   A. Connect a long section of flexible tubing to the vent port on the Instrument J-box Panel and to the hydrogen sensor in a protected location on deck.
      1) If the LEL reading is less than 10% proceed to Step 4.
      2) If the LEL reading is greater than 10% proceed to Step 3.
3. **Purge the buoy well with nitrogen** –

Figure 5: Nitrogen Tank, Regulator and Flexible Tubing


Figure 6: Eagle 2 Gas Analyzer

Figure 7: Monitor and Purge Ports

A. Connect a long section of flexible tubing to the vent purge port on the Instrument J-box Panel and to a cylinder of nitrogen gas.
B. Flush the well with 2-4 psi of nitrogen until the hydrogen sensor records less than 10% LEL.

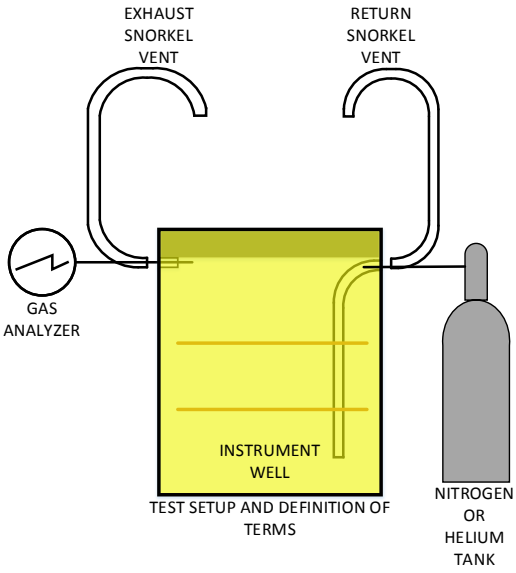

Figure 8: Instrument well purge procedure setup

4. **Insert magnet to shut down buoy** –
   A. Secure a magnet on the J-Box Status panel to shut down the Surface Buoy.
   B. Remove high power interlock jumper if installed.
5. **Secure the buoy on deck** –
   A. Apply tie-down straps as needed to secure the buoy on deck.

Once the buoy is on deck, purged and secured, mooring recovering operations can continue. The surface buoy should continue to be monitored using the hydrogen sensor and flushed as needed with nitrogen.

6.6. Shipboard/transit Actions

Following mooring recovery, transit times will vary depending on the Array location. Coastal Pioneer cruises will like return to port within a day or two of recovery. Global cruises may have several days of transit time. To secure the buoy for transit and ensure adequate flushing of the buoy well, the following actions will be performed.

1. **Disconnect Batteries** –
   A. Following mooring recovery, once the buoy has been purged and is secure, the buoy hatch will be opened
      1) Remove connector P5 on the Power System Controller.
   B. The well should be allowed to vent in this configuration for at least 15 minutes (weather dependent), and then secured for transit.
2. **Venting of buoy well** –
   A. Remove vent valves from the tower assembly to enable venting of the well during transit.
   B. Hydrogen measurements should be made at Monitor port daily.

Figure 9: Vent Valve to be removed

7.0 Records

All measurement readings and procedures followed will be recorded in the mooring recovery log.

8.0 Attachments

None.

Material Safety Data Sheet

Nitrogen

PurityPlus Gases
6331 East 30th Street
P.O. Box 19907
Indianapolis, IN 46219-0907
317.562.1483 (tel)
317.562.1484 (fax)

Section 1: Product and Company Identification

PurityPlus Gases
6331 East 30th Street
P.O. Box 19907
Indianapolis, IN 46219-0907
317.562.1483 (tel)
317.562.1484 (fax)

Product Code: Nitrogen

Chemical Substance	Chemical Family	Trade Names
NITROGEN, COMPRESSED GAS	inorganic, gas	DIATOMIC NITROGEN; DINITROGEN; NITROGEN; NITROGEN-14; NITROGEN GAS; UN 1066; N2

Section 2: Hazards Identification

Description	Main Health Hazard
Colorless, odorless Containers may rupture or explode if exposed to heat.	Difficulty breathing

Likely Routes of Exposure:

Inhalation	Ingestion	Eye	Skin	Health Effects	Target Organs	Medical Condition Aggravated by -
Nausea, vomiting, difficulty breathing, headache, drowsiness, dizziness, tingling sensation, loss of coordination, convulsions, coma	Ingestion of a gas is unlikely	Contact with rapidly expanding gas may cause burns or frostbite	No information on significant adverse effects	Difficulty breathing	Respiratory system	Pre-existing conditions of respiratory system.

This material is considered hazardous by the OSHA Hazard Communication Standard (29 CFR 1910.1200).

Section 3: Composition/Information on Ingredients

CAS #
7727-37-9

Section 4: First Aid Measures

Skin Contact	Eye Contact	Ingestion	Inhalation	Note to Physicians
Wash exposed skin with soap and water.	Flush eyes with plenty of water.	If a large amount is swallowed, get medical attention.	If adverse effects occur, remove to uncontaminated area. Give artificial respiration if not breathing. If breathing is difficult, oxygen should be administered by qualified personnel. Get immediate medical attention.	For inhalation, consider oxygen.

Section 5: Fire Fighting Measures

Suitable Extinguishing Media	Products of Combustion	Protection of Firefighters
Non-flammable. Use suitable extinguishing media for surrounding fire. Cylinders may rupture or explode if exposed to heat.	Non-flammable	▪ Respiratory protection may be needed for frequent or heavy exposure.

Section 6: Accidental Release Measures

Personal Precautions	Environmental Precautions	Methods for Containment
Keep unnecessary people away, isolate hazard area and deny entry. Stay upwind and keep out of low areas.	No significant effects from contamination expected.	Stop leak if possible without personal risk.

Methods for Cleanup	Other Information
N/A	N/A

Section 7: Handling and Storage

Handling	Storage
Store and handle in accordance with all current regulations and standards. Subject to storage regulations: U.S. OSHA 29 CFR 1910.101.	Keep seperated from incompatible substances.

Section 8: Exposure Controls/Personal Protection

Exposure Guidelines
NITROGEN, COMPRESSED GAS: NITROGEN: ACGIH (simple asphyxiant)

Engineering Controls

No specific controls are needed.

Eye Protection	Skin Protection	Respiratory Protection
Eye protection not required, but recommened.	Protective clothing is not required.	Respiratory protection may be needed for frequent or heavy exposure.

General Hygiene considerations

- Avoid breathing vapor or mist
- Avoid contact with eyes and skin
- Wash thoroughly after handling and before eating or drinking

Section 9: Physical and Chemical Properties

Physical State	Appearance	Color	Change in Appearance	Physical Form	Odor	Taste
Gas	Clear	Colorless	N/A	Gas	Odorless	Tasteless

Flash Point	Flammability	Partition Coefficient	Autoignition Temperature	Upper Explosive Limits	Lower Explosive Limits
Not flammable	Not available	Not available	Nonflammable	Nonflammable	Nonflammable

Boiling Point	Freezing Point	Vapor Pressure	Vapor Density	Specific Gravity	Water Solubility	pH	Odor Threshold	Evaporation Rate	Viscosity
-321 F (-196 C)	-346 F (-210 C)	760 mmHg @ -196 C	0.967	Not applicable	1.6% @ 20 C	Not applicable	Not available	Not applicable	0.01787 cP @ 27 C

Molecular Weight	Molecular Formula	Density	Weight per Gallon	Volatility by Volume	Volatility	Solvent Solubility
28.0134	N2	1.2506 g/L	Not available	100%	1	Soluble: Liquid ammonia

Section 10: Stability and Reactivity

Stabilty	Conditions to Avoid	Incompatible Materials
Stable at normal temperatures and pressure.	Stable at normal temperatures and pressure.	Metals, oxidizing materials

Hazardous Decomposition Products	Possibility of Hazardous Reactions
Oxides of nitrogen	Will not polymerize.

Section 11: Toxicology Information

Acute Effects

Oral LD50	Dermal LD50	Inhalation
Not available	Not available	Nausea, vomiting, difficulty breathing, headache, drowsiness, dizziness, tingling sensation, loss of coordination, convulsions, coma

Eye Irritation	Skin Irritation	Sensitization
Contact with rapidly expanding gas may cause burns or frostbite	No information on significant adverse effects	Difficulty breathing

Chronic Effects

Carcinogenicity	Mutagenicity	Reproductive Effects	Developmental Effects
Not hazardous	Not available	Not available	No data

Section 12: Ecological Information

Fate and Transport

Ecotoxicity	Persistence / Degradability	Bioaccumulation / Accumulation	Mobility in Environment
Fish toxicity: Not available Invertibrate toxicity: Not available Algal toxicity: Not available Phyto toxicity: Not available Other toxicity: Not available	Not available	Not available	Not available

Section 13: Disposal Considerations

Dispose in accordance with all applicable regulations.

Section 14: Transportation Information

U.S. DOT 49 CFR 172.101

Proper Shipping Name	ID Number	Hazard Class or Division	Packing Group	Labeling Requirements	Passenger Aircraft or Railcar Quantity Limitations	Cargo Aircraft Only Quantity Limitations	Additional Shipping Description
Nitrogen, compressed	UN1066	2.2	Not applicable	2.2	75 kg or L	150 kg	N/A

Canadian Transportation of Dangerous Goods

Shipping Name	UN Number	Class	Packing Group / Risk Group
Nitrogen, compressed	UN1066	2.2	Not applicable

Section 15: Regulatory Information

U.S. Regulations

CERCLA Sections	SARA 355.30	SARA 355.40
Not regulated.	Not regulated.	Not regulated.

SARA 370.21

Acute	Chronic	Fire	Reactive	Sudden Release
Yes	No	No	No	Yes

SARA 372.65

Not regulated.

OSHA Process Safety

Not regulated.

State Regulations

CA Proposition 65
Not regulated.

Canadian Regulations

WHMIS Classification
A

National Inventory Status

US Inventory (TSCA)	TSCA 12b Export Notification	Canada Inventory (DSL/NDSL)
Listed on inventory.	Not listed.	Listed on inventory.

Section 16: Other Information

NFPA Rating
HEALTH=1 FIRE=0 REACTIVITY=0

0 = minimal hazard, 1 = slight hazard, 2 = moderate hazard, 3 = severe hazard, 4 = extreme hazard